# €SENSE INTERFACE 009

## USER'S GUIDE

**CENTRE FOR MICROCOMPUTER APPLICATIONS**

http://www.cma-science.nl

**For our international customers…**
Check the CMA International website (www.cma-science.nl/english) for the latest version of this manual and updates of Coach software products.

**Aan onze Nederlandse gebruikers…**
€Sense wordt standaard uitgeleverd met Engelse handleiding.
U kunt de laatste versie van de Nederlandse handleiding en de nieuwste update van Coach downloaden van de CMA-website (www.cma-science.nl).

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# TABLE OF CONTENTS


**I. GETTING ACQUAINTED** 4

**1. Introduction** 4

**2. €Sense components** 4

**3. €Sense operating system** 5

**4. Computer and software requirements** 5

**5. Attaching €Sense to the computer** 5

**6. Resetting €Sense** 5

**7. Connecting external temperature sensor** 5

**II. USING €SENSE WITH THE COMPUTER** 6

**1. Working with Coach 6** 6

**2. Working with sensors in Coach Activities with €Sense** 6

**3. Working with actuators in Coach Activities with €Sense** 7

**4. Example of a measurement with €Sense and Coach** 8

**III. TECHNICAL SPECIFICATIONS OF €SENSE** 10

**1. Connection to the computer** 10

**2. Power Supply** 10

**3. Sampling rates** 10

**4. Memory** 10

**5. €Sense sensors** 11

5.1. Sound sensor ..... 11
5.2. Light sensor ..... 11
5.3. Temperature sensor ..... 12
5.4. External temperature sensor ..... 13

**6. €Sense actuators** 13

# I. GETTING ACQUAINTED

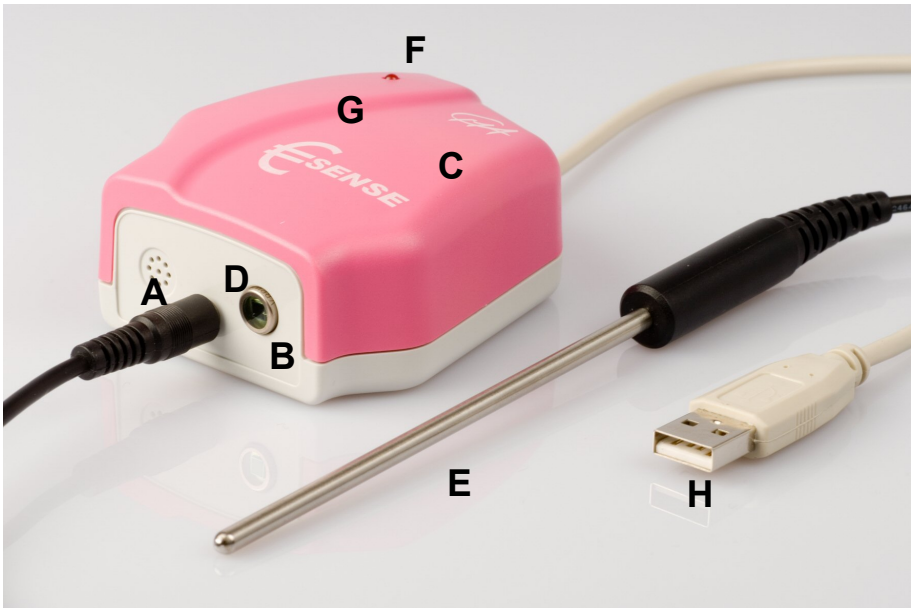
## 1. Introduction

The CMA €Sense is an easy to use USB lab interface with three built-in sensors to measure temperature, sound and light. To the additional input an external temperature sensor, included in the package, can be connected. The built-in LED and speaker can be used as actuators in simple control experiments.

€Sense is connected directly to the computer through a USB-port. The interface is equipped with its own processor and memory, enabling fast measurements with accurate timing. The *FLASH* memory allows easy upgrade of the internal system software.

## 2. €Sense components

The €Sense package contains the €Sense interface, the external temperature sensor and the €Sense Coach 6 Lite CD.




€Sense is provided with (see figure above):

A. Sound sensor with two measuring ranges -9.5 .. 9.5 Pa and 50 .. 110 dB,
B. Light sensor with three measuring ranges 0 .. 1500 lux, 0 .. 15 kilolux, and 0 .. 150 kilolux,
C. Placed inside the housing temperature sensor with measuring range 5 .. 45 °C,
D. Input for the external temperature sensor,
E. External temperature sensor with measuring range -10 .. 120 °C,
F. LED indicating interface initialization, and which can also be used as an actuator,
G. Placed inside the housing buzzer for control activities,
H. USB cable.

€Sense is powered via the USB port and does not need an extra power supply.

## 3. €Sense operating system

€Sense is equipped with an internal operating software (firmware). The firmware is stored in FLASH memory, which allows easy update of €Sense operating system.
The firmware update can be performed manually by using CMA Firmware Update program or automatically via Coach 6 and Coach 6 Lite. Coach recognizes automatically when a connected €Sense need to be updated and offers direct update. For the latest versions of CMA software check the website www.cma-science.nl.

## 4. Computer and software requirements

To use €Sense with the computer you need Coach 6 or Coach 6 Lite version 6.2 or higher running on a Pentium III computer with Win 2000/XP/Vista/Win 7 with at least 192 MB RAM (recommended 256 MB) and unused USB port.

## 5. Attaching €Sense to the computer

To connect €Sense to your computer simply plug its USB-plug into a free USB-port of the computer. The LED of the interface will switch on for a short period of time. This means that the interface initializes. Windows might show a notice that a new USB-device is found. After €Sense is detected, Coach 6 Lite will start automatically and the €Sense project will open.
Automatic detection of €Sense can be switched off by right clicking the Coach 6 icon in the taskbar and selecting *Stop*.

## 6. Resetting €Sense

It may happen that the communication between €Sense and the computer is lost. If this happens you have to reset €Sense. This can be done in two ways (in the Coach software):

1. When there is no communication on opening of a Coach Activity/Results and the program displays the message that the panel €Sense can not be initialized then unplug the interface and plug it in again after a few seconds or plug it into another USB-port of your computer. Press *Retry* in Coach.
2. When the communication with the interface is lost while working in a Coach Activity/Result then:
   - Right click the €Sense screen panel.
   - Select the *Reset Hardware* option. This option is only available if the €Sense panel is active in Coach.

## 7. Connecting external temperature sensor

The external temperature sensor can be connected and disconnected at any time by connecting the plug of the external temperature sensor to the input for the external temperature sensor (D) at the front of the €Sense interface.

## II. USING €SENSE WITH THE COMPUTER

To use €Sense with the computer you need a PC computer with the Coach 6 Lite or the Coach 6 program (see '*4. Computer and software requirements'*).
During the measurements €Sense stays connected to the computer. Sampled data are transferred in real time to the computer. The course of the measurement can be followed directly in the Coach program.

### 1. Working with Coach 6

When you work with Coach 6 Lite (6.2 or higher) you can start the program by automatic interface recognition. Plug your €Sense into the USB port, after the interface is detected Coach 6 Lite will start and the €Sense project will open.
When you work with Coach 6 (6.2 or higher) then you have to open Coach via Windows Start menu or via double-clicking a Coach Activity file (*.cma), a Coach Result file (*.cmr) or a Windows shortcut to such file.
Extensive information on working with Coach 6 Lite and Coach 6 can be found respectively in the *Guide to Coach 6 Lite* and *Guide to Coach 6* manuals, and in the on-line Coach Help System.

### 2. Working with sensors in Coach Activities with €Sense

€Sense has three built-in sensors to measure temperature, sound and light. The additional, external temperature sensor can be connected to the input.
The €Sense sensors can be activated in Coach Activities with €Sense by dragging sensor icons to proper inputs of the €Sense screen panel. The sensor icons can be found on the sensor palette or in the Coach Sensor Library.
The €Sense screen panel has 4 inputs:

Input 1 - is used for the built-in sound sensor. There are two sensor icons, available in the Coach Sensor Library, one to measure the sound amplitude (-9,5 .. 9.5 Pa) and one to measure the sound intensity (50 .. 110 dB);

Input 2 - is used for the built-in temperature sensor (5 .. 45 °C);

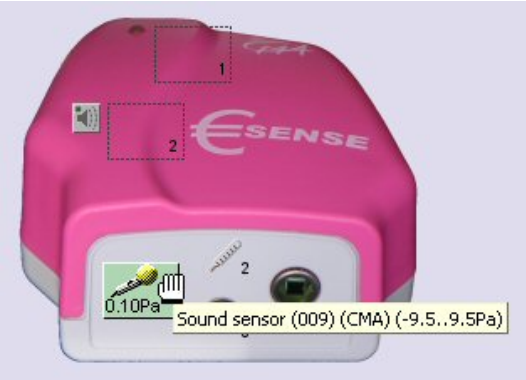
Input 3 - is used for the external temperature sensor (-10 .. 120 °C);

Input 4 - is used for the built-in light sensor. There are three sensor icons, available in the Coach Sensor Library, with different light intensity ranges (0 .. 1500 lx, 0 .. 15 klx, and 0 .. 150 klx).

Inputs of the €Sense screen panel.

If you miss a sensor icon on the sensor palette in Coach Activity you have to add it manually from the Coach Sensor Library.

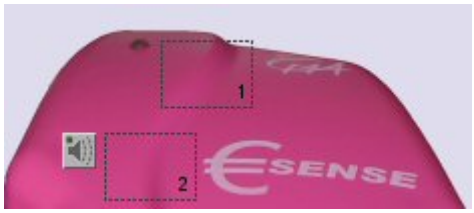
- Click an empty place on the sensor palette, click *Select from Library*, select the desired sensor from the list and click *OK*.
- Drag a sensor icon from the sensor palette to its input on the €Sense screen panel.
- Calibrated signal values measured by the sensor will be displayed on the icon.



Sometimes it is useful to count signal changes of an analog sensor as pulses, e.g. to measure how often the screen is refreshed (using a light sensor as counter). With €Sense it is possible to define analog sensors as counters. If the analog signal of such a sensor crosses a specified value (threshold) in a predefined direction, the counter is incremented by one. (For detailed information see *Guide to Coach 6 Lite* or *Guide to Coach 6*).

## 3. Working with actuators in Coach Activities with €Sense

€Sense has two built-in actuators, the LED and the buzzer, which can be used as actuators in simple control experiments.
The €Sense actuators can be activated in Coach Activities with €Sense by dragging sensor icons to proper outputs of the €Sense screen panel. The sensor icons can be found on the actuator palette or in the Coach Actuator Library.



Outputs of the €Sense screen panel.

The €Sense screen panel has two outputs:
Output 1 - is used for the built-in LED;
Output 2- is used for the built-in buzzer.

If you miss an actuator icon on the actuator palette in Coach Activity you have to add it from the Coach Actuator Library.

- Click an empty place on the actuator palette, click *Select from Library*, select the desired actuator from the list and click *OK*.
- Drag an actuator icon from the actuator palette to its output on the €Sense

screen panel.

- Click the small icon next to the actuator icon to manually toggle actuator on or off.
- With the power slider on the actuator icon, you can adjust its power level. Click an arrow at the right side of the actuator icon to increase or decrease the power. The height of the red bar indicates the level of the output.
  In this way you can adjust the LED brightness and you can generate different buzzer sounds.

## 4. Example of a measurement with €Sense and Coach

Guided by this step-by-step tutorial you can perform your first temperature measurements with €Sense and its external temperature sensor. Before you start make sure that the Coach 6.2 Lite software is installed on your computer.
In this experiment you are going to investigate temperature variations of water in a beaker. During this measurement €Sense collects temperature data and the measured data are displayed on the screen in a graph, a table and as a digital value. The measured value is also displayed on the sensor icon on the €Sense screen panel.

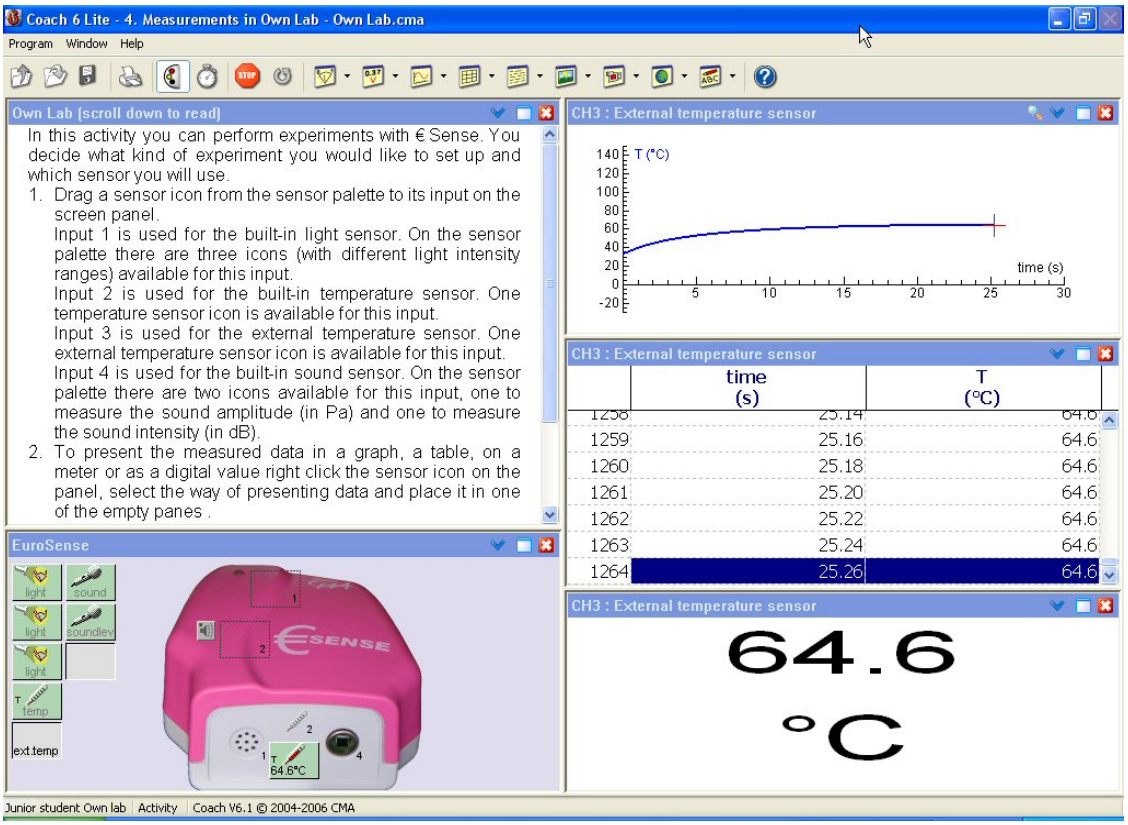
***Materials:***

- €Sense with an external temperature connected
- PC computer with the Coach 6.2 Lite
- 250 mL beaker and 100 mL hot water

***Measurement procedure***

1. Connect €Sense to the computer.
2. After €Sense is detected Coach 6 Lite will start automatically and the €Sense project will open.
3. Open the project *Measurements in Own Lab* and select the activity *Own Lab*.
4. Plug the external temperature sensor into the input of €Sense.
5. Drag the external temperature sensor icon from the sensor palette to input 3 of the €Sense screen panel.
6. Right click the icon and select *Display as Diagram*. Place the diagram in one of the empty panes.
7. Right click the icon and select *Display as Table*. Place the table in one of the empty panes.
8. Right click the icon and select *Display as Value*. Place the value in one of the empty panes.
9. Determine the room temperature.
10. Fill a beaker with hot water and place the temperature sensor in the water.
11. Click the *Measurement settings* button and set the measuring time to 3 minutes, and measurement frequency to 50 per second.

12. Click the green *Start* button to start a measurement.
13. The measurement stops after the measuring time is reached or by clicking the red *Stop* button.
14. Analyze the measured data. All processing and analysis tools of Coach are available from the Diagram and Table Tool menus.


Coach 6 Lite - 4. Measurements in Own Lab - Own Lab.cma
Program Window Help
Own Lab (scroll down to read)
In this activity you can perform experiments with € Sense. You decide what kind of experiment you would like to set up and which sensor you will use.
1. Drag a sensor icon from the sensor palette to its input on the screen panel.
Input 1 is used for the built-in light sensor. On the sensor palette there are three icons (with different light intensity ranges) available for this input.
Input 2 is used for the built-in temperature sensor. One temperature sensor icon is available for this input.
Input 3 is used for the external temperature sensor. One external temperature sensor icon is available for this input.
Input 4 is used for the built-in sound sensor. On the sensor palette there are two icons available for this input, one to measure the sound amplitude (in Pa) and one to measure the sound intensity (in dB).
2. To present the measured data in a graph, a table, on a meter or as a digital value right click the sensor icon on the panel, select the way of presenting data and place it in one of the empty panes .
CH3 : External temperature sensor
T (°C)
time (s)
CH3 : External temperature sensor
time (s)
T (°C)
1259 25.16 64.6
1260 25.18 64.6
1261 25.20 64.6
1262 25.22 64.6
1263 25.24 64.6
1264 25.26 64.6
CH3 : External temperature sensor
64.6
°C
EuroSense
light
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light
temp
ext.temp
64.6°C
Junior student Own lab Activity Coach V6.1 © 2004-2006 CMA

## III. TECHNICAL SPECIFICATIONS OF €SENSE

### 1. Connection to the computer

€Sense is connected to the PC via a USB-port.

| | | |
|---|---|---|
| USB connection | Compatibility | USB 1.0; USB 1.1; USB 2.0 |
| | Max. transfer rate | 64 kB/s |

### 2. Power Supply

€Sense is powered from the USB power supply. Power consumption of the interface with no sensors connected is max. 50 mA.

### 3. Sampling rates

The maximum sample rate depends on the number of active sensors and the way they are used.

In *normal mode*, the interface can take one sample every 100 µs. This means that one sensor can be sampled at 10 kHz and two sensors can be sampled at 5 kHz. Sample rates can be chosen in units of 100 µs, so possible rates are: 10 kHz, 5 kHz, 3.3 kHz, 2.5 kHz, 2.0 kHz, 1.67 kHz etc.

In *fast mode*, the interface takes one sample every 25 µs (sample rate: 40 kHz). During fast mode only one sensor/actuator can be active.

*Counter* operation is possible for one sensor at a time. This sensor is monitored every 200 µs to determine if the sensor signal has passed the set threshold value (up or down). This means that the minimum width of a pulse that must be counted is 200 µs. The maximum frequency of a signal to be counted is 2.5 kHz in case of a symmetric signal. Counter operation is not available in fast mode. The table below gives an overview:

| Number of inputs used | Maximum sample rate |
|---|---|
| one sensor active at a time | Sound and light sensors:<br>max. 10 kHz in normal mode, 40 kHz in fast mode.<br>Temperature sensors: max. 5 kHz |
| two sensors active at a time | max. 5 kHz |
| three sensors active at a time | max. 2.5 kHz |
| four sensors active at a time | max. 2.5 kHz |
| one active counter | 2.5 Hz max. signal frequency |

### 4. Memory

€Sense is equipped with Flash (non-volatile) memory which contains the internal operating system (firmware). Flash memory can be rewritten to update the firmware. For buffering of sampled data, €Sense is equipped with 32 kB of RAM memory which can contain maximal 16,000 samples.

## 5. €Sense sensors

### 5.1. Sound sensor

The €Sense sound sensor measures variations in air pressure caused by sound. The sound sources that can be used with the microphone are tuning forks, electronic keyboards, and musical instruments. You may also investigate a human voice or a whistle. When you use the sound sensor make sure the sound level is in the correct range to produce good wave patterns. If the sound is too loud, the wave pattern will be "clipped off" at the top or bottom. In such a case move the microphone further from the sound source, or turn down the volume of the sound. The sensor can also be used for sound level measurements (dB-measurements).

There are two €Sense sound sensors available in the Coach Sensor Library:

- Sound sensor (009) (CMA) (-9.5 .. 9.5 Pa) - for air pressure measurement,
- Sound sensor (009) (CMA) (50 .. 110 dB) - for dB-measurements.

***Technical data***

| | |
|---|---|
| *Measurement ranges* | –9.5 .. 9.5 Pa (1 kHz)<br>50 .. 110 dB |
| *Frequency range* | 100 .. 16.000 Hz |
| *Resolution using 12 bit A/D converter* | 4.6 mPa (1 kHz) |
| *Accuracy* | ±3 dB over frequency range |
| *Max. sample rate*<br>*- air pressure measurements*<br>*- sound level measurements* | <br>40 kHz<br>2.5 kHz[1] |
| *Max. useful sample rate for sound level measurements* | 100 Hz |

### 5.2. Light sensor

The €Sense light sensor is a high sensitivity sensor to measure light intensities in three different ranges 0 .. 1500 lux, 0 .. 15 000 lux and 0 .. 150 000 lux.

The light sensor has an excellent linear response and is equipped with a built-in color correction filter giving an approximation to the spectral response of the human eye.

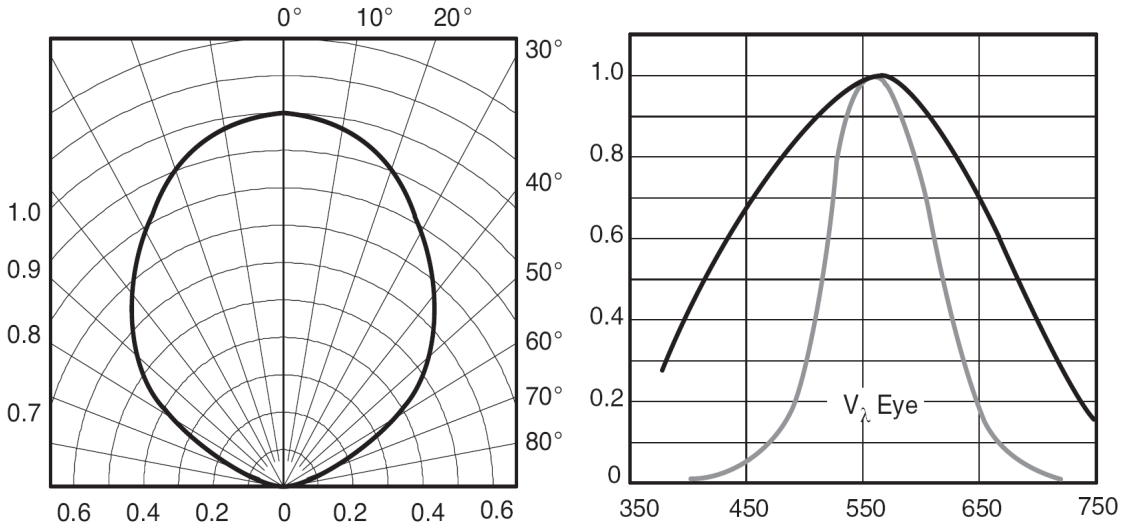
There are three €Sense light sensors available in the Coach Sensor Library:

- Light sensor (009) (CMA) (0 .. 1500 lux)
- Light sensor (009) (CMA) (0 .. 0 .. 15 klux)
- Light sensor (009) (CMA) (0 .. 0 .. 150 klux)

[1] If you choose a sample interval that is shorter than the wavelength of the sound to be measured, the measured sound level will not be representative of the true sound level.

***Technical data***

| | |
|---|---|
| *Measurement ranges* | 0 .. 1500 lux,<br>0 .. 15 klux<br>0 .. 150 klux |
| *Resolution using 12 bit A/D converter* | 0.37 lux (0 .. 1500 lux range)<br>3.7 lux (0 .. 15 klux range)<br>37 lux (0 .. 150 klux range) |
| *Wavelength of peak sensitivity* | 565 nm |
| *Angle of half sensitivity:* | 50° |
| *Response time* | 0.2 ms |
| *Radiant sensitivity area* | 7.5 $mm^2$ |
| *Temperature coefficient* | 0.05 %/°C |
| *Max. sample rate* | 40 kHz |




Light sensor characteristics
*Left*: relative radiant sensitivity vs. angular displacement.
*Right*: relative spectral sensitivity vs. wavelength in nm (black line).
The sensitivity of the human eye is included for reference (grey line).

### 5.3. Temperature sensor

The internal temperature sensor measures temperature in the range of 5°C to 45°C. Because the processor and other components of €Sense generate some heat the internal temperature of the interface will rise by 3 to 4 °C over a period of approximately 45 minutes. The internal temperature sensor will measure this temperature rise.

The name of the internal temperature sensor in the Coach Sensor Library is Temperature sensor (009) (CMA) (5 .. 45°C).

***Technical data***

| | |
|---|---|
| *Measurement range* | 5 .. 45 °C |
| *Resolution using 12 bit A/D converter* | 0.02 °C (20 °C); 0.1 °C (100 °C) |
| *Accuracy* | ±1 °C |
| *Maximum sample rate* | 5 kHz |
| *Recommended max. sample rate* | 1 kHz, above the accuracy may degrade slightly |

### 5.4. External temperature sensor

To the additional input bus of €Sense an external temperature sensor can be connected (included in the package). This sensor can be used for temperature measurements in air or fluids. It measures temperature in the range of -10 .. 120 °C. The name of the external temperature sensor in the Coach Sensor Library is External temperature sensor (009) (CMA) (-10 .. 120°C).

***Technical data***

| | |
|---|---|
| Measurement range | -10 .. 120°C |
| Resolution using 12 bit A/D converter | 0.03 °C (20 °C); 0.1 °C (100 °C) |
| Accuracy | ±0.25 °C (20 °C); ±0.4 °C (100 °C) |
| Rise time / fall time | 20 s for 99 % of final value (water) |
| Maximum sample rate | 5 kHz |
| Recommended max. sample rate | 1 kHz, above the accuracy may degrade slightly |

## 6. €Sense actuators

€Sense has two built-in actuators, LED and buzzer. The LED output can be set to 16 intensity levels and the buzzer output can generate 16 fixed tones.

***Warranty:***

The €Sense is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if €LAB has been damaged by accident or misuse.

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***Note:*** *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

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